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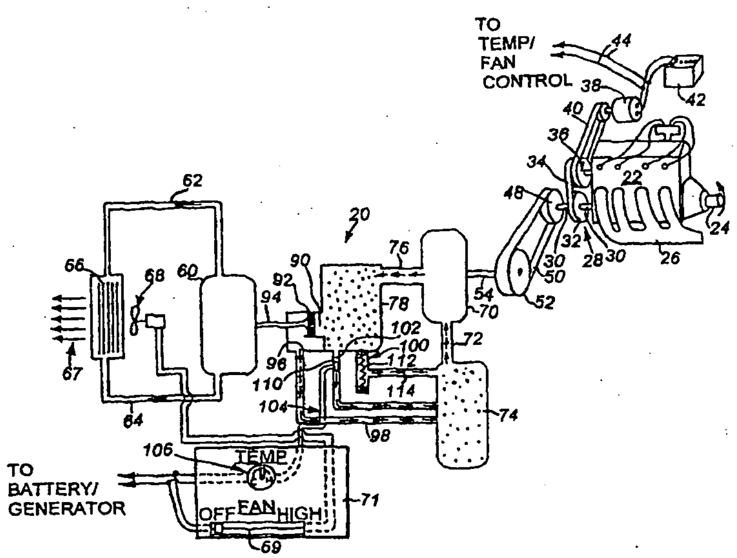
(54) Title: AUTOMOTIVE FLUID CIRCULATING SYSTEM



(57) Abstract

An automotive fluid circulating system is provided. The circulating system includes a vehicle fluid circulating pump (60). A reservoir (74) having fluid can be provided. A pump (70) is interconnected with the reservoir (74) and operatively interconnected with and driven by an engine (22) of a vehicle. The pressure chamber (78) is interconnected with the pump (70) and receives fluid from the pump. A fluid drive element (92), located relative to the pressure chamber (78), and interconnected with the circulating pump (60), converts a passage of pressurized fluid therethrough into mechanical driving force for driving the circulating pump (60). A regulator maintains a selected level of pressure in the pressure chamber and diverts excess fluid from the pressure chamber to the reservoir so that a constant circulating pump power output is maintained.

AUTOMOTIVE FLUID CIRCULATING SYSTEM

RELATED APPLICATIONS

This is a continuation-in-part of co-pending U.S. Patent Application Serial No. 08/491,790, filed June 19, 1995.

FIELD OF THE INVENTION

This invention relates to a fluid circulating system for a vehicle and more particularly to an air conditioning system that operates at a constant power level with increased reliability regardless of engine speed.

BACKGROUND OF THE INVENTION

Air conditioning and other fluid transport mechanisms are highly desirable and, in some instances, an essential feature in modern automobiles and other vehicles. In a typical air conditioning installation, a compressor is used to pressurize and propel a volatile refrigerant such as Freon through a closed-loop system. A cooling coil is provided in the closed loop within the passenger compartment of the vehicle. The compressed, liquid phase, refrigerant expands into a gaseous phase as it passes through the cooling coil causing ambient heat to be withdrawn from the surrounding air. The withdrawal of heat cools the vehicle. The heated, expanded, refrigerant is subsequently repressurized by the compressor, causing loss of heat to the outside air. So long as the compressor continues to operate, the refrigerant continues to circulate through the system exchanging heat between the inside and the outside of the vehicle by an associated phase change in the refrigerant.

The air conditioning compressor in most vehicles is powered by direct interconnection with the engine which, in most cases, is an internal combustion engine

include a shutoff control that signals the clutch to disengage from the engine. Hence at high speeds the compressor continually cycles on and off. This can lead to discomfort on hot days in which continual cooling is required.

Similarly, it has been shown that the compressor suffers accelerated damage when it is operated at high RPMs. Thus, it is often desirable to deactivate the air conditioning when cruising. This can lead to discomfort on very-hot days.

As discussed above, the operation of the air conditioner compressor's clutch can lead to further damage since, at high RPMs, the sudden activation of the clutch sends a shock through the compressor as it is "slammed on". There is also increased risk of fan belt breakage when the clutch suddenly engages the compressor at higher speed. It would be preferable to power the compressor via a gradual acceleration to a fully-powered state.

It is, therefore, an object of this invention to provide an air conditioning system for vehicles that operates at a substantially constant speed and cooling output regardless of engine speed. It is a further object of this invention to provide an air conditioning system that operates continuously at a speed that minimizes air conditioning compressor damage. It should be possible to activate and deactivate the compressor at will, while the engine is operating at any speed without risk of damage to the compressor or other engine components. Cooling output by the system should not be excessive at high engine speed and should be sufficient at idle and low engine speed. The principles herein should be applicable to a variety of fluid circulating system such as power steering and power brake pumps.

In another embodiment, the fluid pump can comprise a first impeller that is enclosed is an integral casing with a drive element comprising a second impeller. A manifold pipe having three inlets is attached to the casing. The manifold pipe includes openings upstream of the first impeller, between the first impeller and the second impeller and downstream of the second impeller. The first impeller is attached to a source of motive power for a vehicle such as an engine. The second impeller drives a vehicle fluid circulating pump such as an air conditioning compressor, a power steering pump, a power brake pump or another fluid circulating/hydraulic pump used on a vehicle. Fluid should be taken to include gases and, thus, pneumatic pumps for air brakes and the like can also be driven by the second impeller. The openings between the first and second impellers and downstream of the second impeller include respective first and second regulator valves. The first regulator valve can be a pressure-operated check valve that maintains a predetermined pressure at the outlet of the first impeller. The second regulator valve can be a control valve that regulates fluid flow through the second impeller to control an overall speed of operation and power output of the second impeller. The first control valve and the second control valve can each be interconnected with a controller that balances the two valves so that a desired fluid flow is maintained. A reservoir can be provided at any point within the fluid path to absorb excess pressure and/or to insure that a predetermined level of fluid is maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and advantages of the invention will become more clear with reference to the following detailed description as illustrated by the drawings, in which:

The engine 22 according to this embodiment also includes a front power takeoff 28 comprising a drive shaft 30 that is, in this embodiment, a portion of the engine's crank shaft (not shown), that is also interconnected with the drive shaft 24. The power takeoff 28 includes a pulley 32 that drives a power transmission belt 34 interconnected with an additional pulley set 36. The pulley set 36 is used to power a generator 38 via an additional power transmission belt 40. A variety of components can be interconnected by associated power transmission belts and pulleys to the main power takeoff 28. For example, a water pump, a cooling fan, a power steering pump, and, of course, an air conditioning compressor can all be linked by associated belts that are in rotational communication with the power takeoff 28. In addition, a plurality of power takeoffs can be provided to the front of the engine using gears located within a gear case. The generator 38 according to this embodiment powers a battery 42 for reserve electrical energy. The generator 38 and battery 42 are used, in part, to power auxiliary systems such as climate control, lighting, radio and instrumentation via power output cables 44.

The power takeoff 28 is interconnected with another drive pulley 48 that, in this embodiment, is provided on the drive shaft 30. It should be clear that the pulley 48 can be provided at any position relative to the engine 22 and can be driven by gears or another drive belt according to an alternate embodiment.

The pulley 48 drives a power transmission belt 50 that is interconnected with an opposing drive pulley 52. According to this embodiment, the pulley 52 is interconnected to a drive shaft 54 that powers the air conditioning system 20 according to this invention. The air conditioning system 20 will now be described in further detail.

The air conditioning system 20 includes an air conditioning compressor 60 that circulates a refrigerant through a closed-loop comprising an output line 62 and a return

channels that, in substance, control the operation of the air conditioning system 20 according to this invention. The primary outlet of the chamber 78 is a turbine housing 90 that encloses a turbine blade 92 of conventional design. Other fluid pressure-to-mechanical motion devices are also expressly contemplated. In this embodiment, the turbine blade is impelled by the fluid under pressure. The fluid causes the turbine blade to rotate a drive shaft 94 that is interconnected with the air conditioning compressor 60 according to this invention. As described below, by varying the pressure in the chamber, the rotation of the turbine blade 92 can be controlled and/or enabled and disabled on command. When fluid passes through the turbine blade 92, it is routed to a return port 96. It is transferred by a line 98 back to the reservoir 74 where it is reused by action of the pump 70.

Since the pump 70 is interconnected directly with the engine, it's speed of operation will vary in proportion to the speed of the engine. Hence, at various times larger and smaller amounts of fluid are transferred into the pressure chamber 78, resulting in higher and lower fluid pressures in the chamber 78. The pressure chamber 78 and turbine 92 are sized and structured so that at an idle speed, a minimum acceptable rotation of the air conditioner compressor 60, via the turbine 92, occurs. However, to prevent excessive rotation at higher engine speeds, the system 20 must account for the substantial increase in fluid pressure in the chamber 78 resulting from high speed driving of the pump 70. Accordingly, a pair of waste ports 100, 102 are provided upstream of the turbine 92 within the chamber 78. These waste ports 100, 102 act to control the excess pressure in the chamber 78 by routing fluid back to the reservoir 74.

Reference is made first to the control waste port 102 that is electrically connected by wires 104 to a temperature control switch 106 on the control console 71. The temperature control switch 106, according to this embodiment, can comprise any

in the chamber 78. As described further below, when fluid pressure in the chamber exceeds a predetermined maximum value, the valve 112 is signaled to open and direct excess fluid through the line 114 back to the reservoir 74.

With further reference to FIGS. 2-4, the valve 112 is detailed in a fully closed (FIG. 2), partially opened (FIG. 3) and fully opened (FIG. 4) state of operation. As noted, the valve 112 according to this embodiment is a form of check valve. The valve 112 consists of an inlet 116 that enables fluid (see arrows 118) to enter the valve housing 120. The inlet 116 can include a seal or other structure that engages a moving stop 122. The stop 122, according to this embodiment, is a hemispherical plug. It is contemplated that any suitable shape of movable stop can be utilized according to this invention. Such stops can include an elastomeric or metallic ball, a cylinder, a cone or any other structure that maintains a breakable seal relative to a pressure chamber 78 in (FIG. 1). The stop 122 in this embodiment is biased against the inlet 116, in a sealed relationship, by a spring 124. The spring 124 in this embodiment comprises a compression spring that surrounds a spring guide 125 that is joined to the stop 122. The guide 125 maintains the spring 124 and stop 122 in alignment with the housing 120 as the stop 122 moves relative to the housing 120.

The spring constant of the compression spring 124 is chosen so that the stop 122 maintains a seal against the inlet 116 until a predetermined maximum pressure is reached in the pressure chamber 78 in (FIG. 1). At such time, the force of the spring 124 is overcome by the pressure bearing upon the stop 122 and the stop is moved away from the inlet 116. The resultant motion breaks the seal between the stop 122 and the inlet 116 and enables fluid from the pressure chamber 78 in (FIG. 1) to flow through the valve housing 120 and into the reservoir return line 14

bine 92 so that the turbine is not driven at an excessive, potentially-damaging, speed. Conversely, the system is set so that, at minimum engine RPM, a minimum driving force can be provided to the turbine 92 for powering the air conditioning system. The level of pressure is set at a predetermined "equilibrium" value that is constant throughout the full range of engine speeds. Thus, the compressor is driven at a constant speed regardless of engine speed.

While the system provides a minimum driving force for the air conditioner compressor 60 at low RPM, it is contemplated that auxiliary driving power may be required since there may not exist sufficient driving power to run the compressor at low RPM. Hence, a further clutch-operated linkage (not shown) may join the compressor 60 to the engine at low RPM. Likewise, an electric motor or similar auxiliary power unit (not shown) can be provided to the compressor 60 for driving the compressor at low RPM. The primary advantage of the system of the air conditioning system 20, according to this embodiment, is that excessive driving of the air conditioner system at high RPM is avoided. Likewise, the passage of pressurized fluid from the fluid chamber 78 through the turbine 92 provides a more-gentle transition to the compressor 60 at start-up than the dead-start and dead-stop that is normally associated with a direct-driven compressor having a clutch according to the prior art.

With further reference to FIG. 5, the graph illustrates the difference between a directly-driven air conditioning compressor and an air conditioning compressor driven according to this embodiment. The increasing curve 150 represents the RPMs of a directly-driven compressor. Over approximately 15 miles per hour, according to this example, damage to the compressor can occur through excessive driving speed. Likewise, under approximately 15 mph, the compressor is not operating efficiently since the input RPMs are too low to provide an adequate cooling cycle. Conversely, the per-

directly driven by the motor or by some other rotating portion of the vehicle such as a wheel or an axle. The opposite impeller 222 is interconnected with a driving shaft 240 that is seated within the casing 202 using another sealing bearing 242. The driving shaft 240 is interconnected with a fluid-circulating pump 250 that can comprise an air conditioning compressor, a power steering pump, a power brake pump, or any other pump that moves fluid in an automotive or other vehicle system. All such pumps are represented by the pump 250.

The casing 202 is jointed to a manifold pipe 260. The manifold pipe includes three openings 262, 264 and 266 adjacent each of the respective chambers 208, 210 and 212. Fluid enters the manifold pipe 260 through respective openings 270, 272 and 274 in the casing 202. It is contemplated that the casing 202 and manifold pipe 260 are filled substantially completely with hydraulic fluid. Hydraulic fluid can be added through a stopcock or plug 280 in the casing 202. A reservoir (not shown, but similar to reservoir 74) can be provided in communication with the casing 202. Such a reservoir can be tied to the casing by providing a pipe at, for example, the location of the stopcock 280. This reservoir maintains a predetermined fluid level in the system 200.

The manifold pipe openings 264 and 266 adjacent respective chambers 210 and 212 include movable valves 290 and 292. Each of the valves 290 and 292 includes a moving baffle 294 and 296 that controls the flow of fluid into the respective openings 264 and 266. The baffles can be operated mechanically, hydraulically or electrically and are interconnected to a controller as detailed in Fig. 6. Control stems 298 and 300 (Fig. 7) can be provided to mechanically (rotatably) interconnect the baffles with an appropriate actuator. While baffles are shown in this embodiment, it is contemplated

that when the valve 296 is fully closed, fluid cannot flow freely through the impeller 222 and, thus, the driven shaft 240 remains stationary.

The valve 294 can be controlled mechanically by an external actuator, or it can be interconnected with a spring assembly similar to that described for the valve 100 in Fig. 1. As such, the valve 294 can act as a safety valve to bleed off excess pressure. It should be clear that the system 200 of this embodiment, like that described above with reference to Fig. 1, provides an even driving force for the pump 250 regardless of the input power from the engine. This enables more efficient operation of fluid-driven components and accessories on a vehicle without the undesirable effects brought on by engine acceleration and deceleration.

The foregoing has been a detailed description of a preferred embodiment. Various modifications and additions can be made without departing from the spirit and scope of this invention. For example, the check valve utilized herein is a mechanical ball-and-spring-type valve with a stop that seals against an inlet. A rotating valve or another type of valve that opens selectively in response to pressure can be substituted. Additionally, an electrically operated-valve that opens and closes in response to a sensed pressure in the pressure chamber can also be substituted. Such a valve would include a pressure transducer or other sensor within the pressure chamber and would be directed to open and close to allow a predetermined volume of fluid to escape for a predetermined time based upon the sensed pressure in the chamber. Additionally, while the fluid pump of this invention is connected to the engine, it can also be connected to other portions of the drive train such as the transmission or wheel axles. In addition a reservoir can be provided in each of the above-described embodiments to absorb excess fluid pressure at any point along the fluid flow path where desirable. As such, this

CLAIMS

1. A system for powering a vehicle fluid circulating pump comprising:

a first fluid impeller having an inlet and an outlet operatively interconnected with a source of motive power of the vehicle;

a first regulator valve located adjacent the outlet and in fluid communication with the impeller and a return pipe connected to the first regulator valve and in fluid communication with the inlet;

a second fluid impeller located adjacent the outlet and being constructed and arranged to be driven by fluid impelled by the first fluid impeller, the second fluid impeller being operatively connected to the vehicle fluid circulating pump; and

a controller that open and closes the first regulator valve in response to each of a pressure level at the outlet and a desired power level at which the second fluid impeller is impelled.

2. The system as set forth in claim 1 further comprising a second regulator valve located at an outlet of the second fluid impeller, the second regulator valve being constructed and arranged to open and close to regulate an amount of fluid passing through the second fluid impeller.

3. The system as set forth in claim 2 further comprising a sensor located adjacent the outlet that generates a control signal interconnected with the controller for selectively varying the pressure at the outlet to, thereby, vary a pressure of fluid directed to the second fluid impeller.

4. The system as set forth in claim 3 wherein the controller is constructed and arranged to open and close the first regulator valve to maintain a predetermined constant pressure adjacent the second fluid impeller at predetermined times whereby the second fluid impeller is impelled at a substantially constant power at the predetermined times.

11. The method as set forth in claim 10 wherein the step of a valve adjacent the pressure chamber in response to a measured pressure chamber in response to a measured pressure in the pressure chamber in response to a measured pressure in the pressure chamber.

12. The method as set forth in claim 11 further comprising controlling a level of fluid passing through the drive element to vary a power output of the drive element.

13. The method as set forth in claim 12 wherein the step of controlling includes opening and closing a control valve at an outlet adjacent a downstream end of the drive element and directing fluid from the control valve back to the impeller.

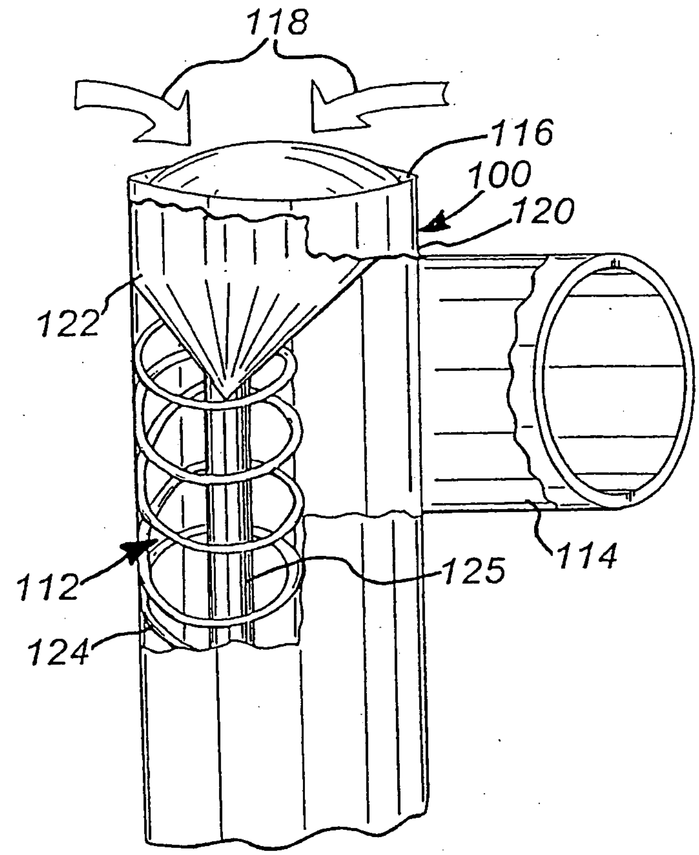


Fig. 2

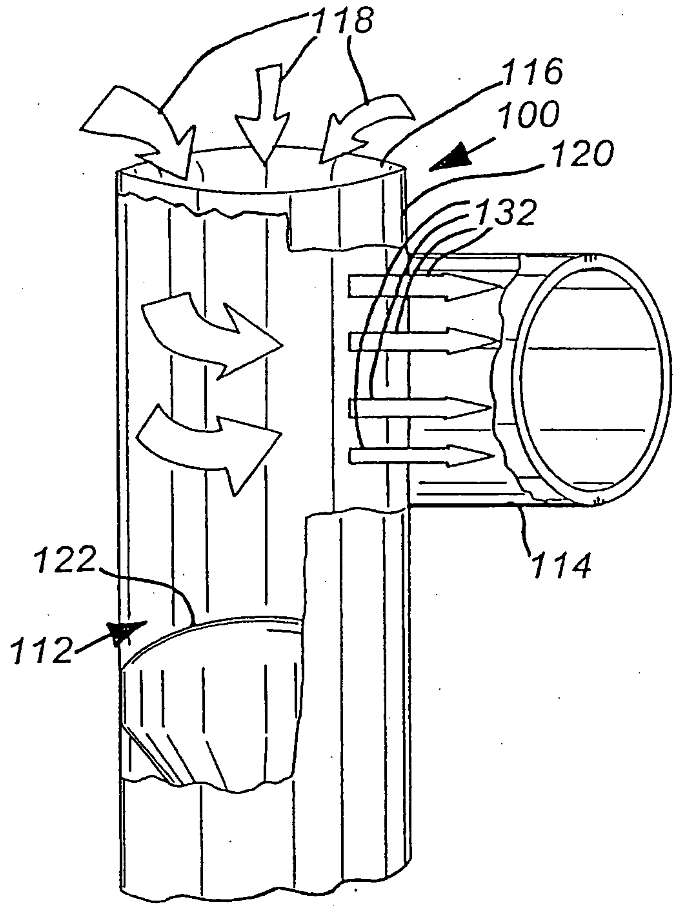


Fig. 4

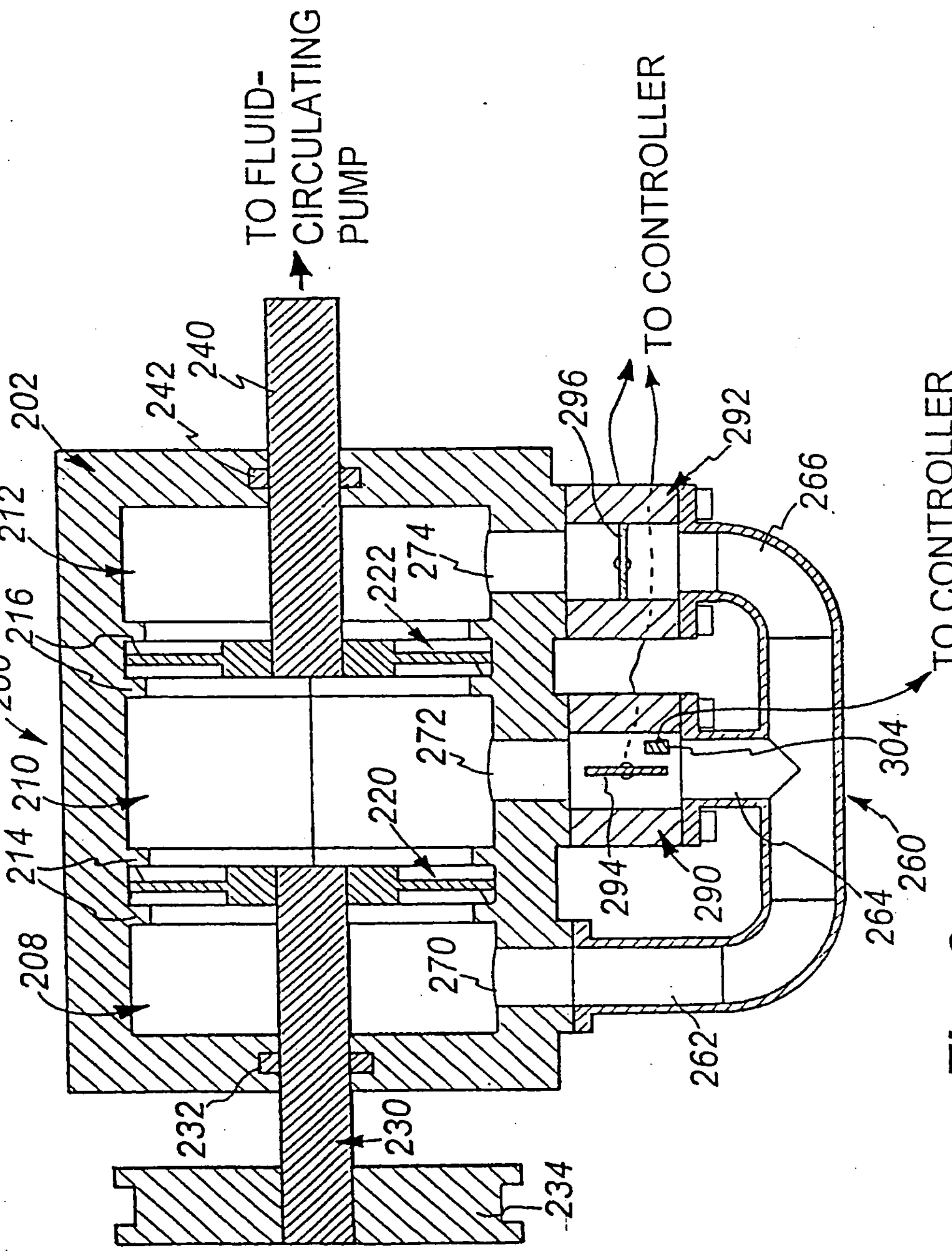

TO FLUID-
CIRCULATING
PUMP
TO CONTROLLER
TO CONTROLLER
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Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/05763

A. CLASSIFICATION OF SUBJECT MATTER

B 60 K 25/04,B 60 H 1/32,F 16 D 31/06

According to International Patent Classification (IPC) or to both national classification and IPC6

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B 60 K,B 60 H,F 16 D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 4320655 A1 (MAN NUTZFAHRZEUGE AG) 05 January 1995 (05.01.95), abstract, column 2, lines 42-62, fig. 2. --	1
A	US 5333679 A (SUZUKI et al.) 02 August 1994 (02.08.94), abstract, fig. 1,2. --	1
A	GB 1528022 A (STEIGER) 11 October 1978 (11.10.78), page 9, line 48 - page 10, line 16, fig. 8. ----	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 1997	30.10.97

Name and mailing address of the ISA	Authorized officer
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